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AUTHOR	Neuschatz, Michael; Mulvey, Patrick J.; Nicholson, Starr
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ABSTRACT

This report provides data on students earning physics and astronomy bachelor's degrees for the 1997-98 academic year. The report notes that: (1) after many years of steady decline, the number of undergraduates earning physics bachelor's degrees has stabilized, with 3,821 degrees awarded in 1997-98; (2) declines in undergraduate degrees persist at generally larger departments that also teach physics at the graduate level--for these schools, the cumulative decrease since 1989 is 32 percent; (3) satisfaction levels among physics bachelor's recipients appears high; (4) roughly half of new bachelor's recipients plan to immediately enter graduate school, with 31 percent planning to pursue physics studies and 19 percent planning to pursue other disciplines; (5) of students continuing on to graduate study, 86 percent expect to earn doctoral degrees and 61 percent hope for careers as college or university professors, percentages far higher than historically achieved; (6) physics and astronomy seniors perceive their respective post-baccalaureate job markets very differently, with physics seniors believing their potential employment prospects are far more positive than do their astronomy counterparts; and (7) perhaps as a result of their poorer bachelor-level job market, the proportion of astronomy graduates going directly to graduate school is higher (55 percent) than in physics. More than two-thirds of astronomy matriculates aspire to academic careers. Tables and figures summarize the data. (CH)

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AMERICAN INSTITUTE OF PHYSICS

AIP

ne Physics Ellipse
ollege Park, MD 20740-3843

EDUCATION AND EMPLOYMENT STATISTICS DIVISION
Tel. 301-209-3070

E-mail: stats@aip.org
http://www.aip.org/statistics

By Michael Neuschatz
Patrick J. Mulvey
Starr Nicholson

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December 1999

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PHYSICS AND ASTRONOMY SENIOR REPORT: CLASS OF 1998

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AIP REPORT

One Physics Ellipse
College Park, MD 20740-3843

EDUCATION AND EMPLOYMENT STATISTICS DIVISION
Tel. 301-209-3070

E-mail: stats@aip.org
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HIGHLIGHTS

- After many years of steady declines, the number of undergraduates earning physics bachelor's degrees in the U.S. has at least temporarily stabilized, with the total being 3,821 for the 1997-98 academic year (see **Figure 1**).

- One place where the decline persists is at the generally larger departments that also teach physics at the graduate level. Among these schools, the cumulative drop since 1989 has now reached 32% (see **Figure 2**).

- Despite enrollment declines, satisfaction levels among physics bachelor recipients appear quite high, with 86% indicating that they would do so again if they had it to do over. For the overwhelming majority of respondents, the reason they chose to study physics was enjoyment of the subject, not because of the career opportunities it offered (see **Figure 3**).

- As in years past, roughly half of the new physics bachelors planned to immediately enter graduate school. This year, 31% planned to pursue studies in physics or a related field and 19% chose to pursue other disciplines, most commonly engineering (see **Figure 4**).

- Regardless of immediate plans, many graduating seniors already had a sense of their long-term career goals (see **Table 2**). Students going on to physics graduate study seem, if anything, over-optimistic, with 86% intending to earn a PhD and 61% hoping to secure a career as a college or university professor. Both figures are far higher than the percentage that historically achieve such goals.

- Physics and astronomy seniors perceive their respective post-baccalaureate job-markets very differently. Physics seniors paint their potential employment prospects in a far more positive light than do their astronomy counterparts (see **Figure 5**).

- Perhaps as a result of the bachelor-level job market outlook, the proportion of bachelor's degree recipients going directly on to graduate school is even higher in astronomy (55%) than in physics. Over two-thirds of these astronomy matriculators aspire to an academic career. As in physics, a very high percentage (86%) of astronomy bachelors seems well-satisfied with their choice of major.

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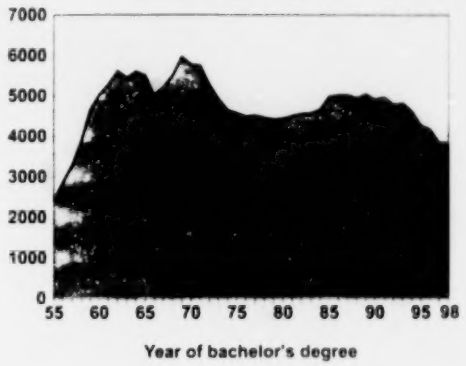
Member Societies The American Physical Society•Optical Society of America•Acoustical Society of America•The Society of Rheology•American Association of Physics Teachers
American Crystallographic Association•American Astronomical Society•American Association of Physicists in Medicine•American Vacuum Society•American Geophysical Union

There are 749 colleges and universities across the United States that confer bachelor's degrees in physics. After four years of steady declines, the number of degrees granted by these departments has at least temporarily stabilized, with 3,821 bachelor's granted during the 1997-98 academic year.

Each year since the late 1970's, senior-level physics majors have been sent a survey, asking them to describe their experiences as undergraduate physics students and their plans for the future. This year, information was gleaned from 1,599 prospective physics bachelor's recipients, supplemented by departmental data gathered in AIP's annual Enrollments and Degrees Survey (report available from our website at www.aip.org/statistics/trends/undtrends.htm). That survey, gathering information on all physics graduates, showed that 19% were women, 95% were US citizens, and 15% were minority group members. Forty-five percent came from schools offering only undergraduate courses in physics. A comparison of these characteristics with responses to the student survey shows that respondents closely resembled the larger population in all but one of these respects, the exception being a slightly higher response rate from female students.

late 1950's. However, true to the recent pattern, departments with graduate physics programs continue to fare worse than those with only undergraduate physics. While the latter showed some evidence of recovery, departments offering physics PhD's especially have yet to reverse the shrinkage in their undergraduate programs (see **Figure 2**). On the other hand, even with these declines, each graduate department still produces on average more than twice the number of physics bachelors as the typical undergraduate-only department.

Figure 1. Physics bachelor's production in the US, 1955 to 1998.



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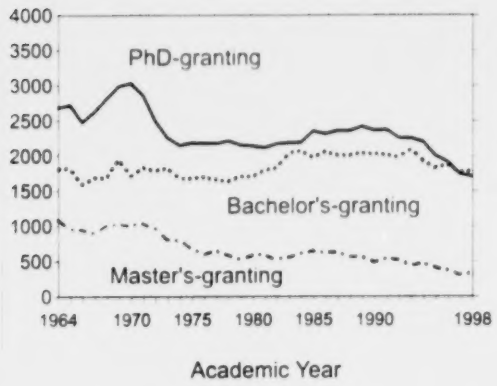
BACKGROUND

Figure 1 shows the nearly half-century record of physics bachelor's degree production in this country. After eight years of substantial declines from the recent peak in 1989, the overall number of physics bachelors conferred appears to be stabilizing, although at a level not seen since the

In contrast to the declining enrollments, responses from the new physics bachelor's recipients provide a generally positive picture. A high proportion of those who chose the discipline emerge with a longstanding commitment to physics, an extremely high level of overall satisfaction with their choice of major and course of study, and a good deal of optimism over their future prospects as well.

Figure 2. Physics bachelor's degrees awarded by department type, 1964-1998.



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Prior exposure seems to be a key ingredient to the successful pursuit of physics in college. While fewer than 30% of all high school graduates take physics in high school, among future physics bachelor's degree recipients the figure exceeds 90%. And 70% feel that their high school course provided an adequate or better preparation for their post-secondary physics studies. While fewer than a third of these students took the more accelerated Advanced Placement (AP) physics course in high school, this turns out to be partly a result of availability, since AP physics is only offered in a minority of schools. Where it was available, 64% of the future physics bachelors took it, compared to only 7% of all high school graduates.

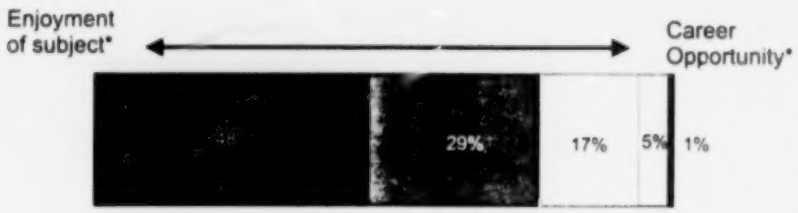
The feelings of satisfaction continue as students move into and through their undergraduate studies. Fully 86% of the bachelor's recipients indicated that if they had it to do over again, they would still major in physics. It is worth noting that this sentiment was held not only by almost all (95%) of those planning to continue on in physics as graduate students, but also by the vast majority of those going out into the work world (82%). Most surprising of all, these feelings are also shared by a large proportion of those switching to another discipline for graduate study (83%). Evidently, both of these latter groups felt that physics provided a useful foundation for their chosen field of work or study.

This year's questionnaire also explored students' motivations for choosing to major in physics in the first place. Asked whether their decision rested more on an intrinsic enjoyment of the subject or on the career opportunities it offered, students overwhelmingly focused on the former, as is evident in **Figure 3**. Once again, not only those continuing on to graduate studies, but also the great majority of those heading out into the job market after college graduation, indicated that they had pursued physics primarily for love of the subject.

UNDERGRADUATE EXPERIENCES

This year's study devoted considerable space to probing aspects of the undergraduate experience that lay beyond coursework. One question centered on the opportunity undergraduates had to participate in physics research projects during their college years. In decades past, this had been primarily the province of graduate students rather than undergraduates. But, as **Table 1** makes evident, physics research has now become an integral part of undergraduate programs,

Figure 3. Primary reason respondents majored in physics, class of 1998.



* Rating of relative importance of these two items on a 5-point scale.

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either as part of a senior thesis project, through participation in a faculty-directed research project, or in a co-operative work arrangement with an outside employer or agency.

While such research was nearly universal among those heading for graduate work in physics (90%), it was also quite common among those heading for grad studies in other fields (70%) or directly into the workforce (63%). Sadly, it was less prevalent (45%) among those aiming to become high school science teachers. This is doubly unfortunate, first because such teachers will have a responsibility to introduce their own future students to a hands-on laboratory experience, and second, because such teachers typically have little opportunity to work in physics research after completing their undergraduate studies.

Table 1. Participation in a physics research project, class of 1998.

No	28%	
Yes	72%	%
	As part of a thesis project	28*
	Department research project	37
	Research outside of department	19
	Other	3

* Percentages add to more than 72% because respondents were allowed to choose more than one option.

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Another part of the undergraduate experience that seems to have become quite prevalent in recent years is the Society of Physics Students, an organization oriented primarily to undergraduates. Affiliated on the national level with the American Institute of Physics, SPS is represented by chapters on an increasing number of campuses across the nation. Among undergraduate respondents, 69% reported an SPS chapter on their campus, and two-thirds of these students described themselves as active participants. These chapters do not seem to be just clubs for those pursuing advanced physics study – students going into other fields or leaving academia after their bachelor's were almost as likely to be active in SPS as those going on to graduate studies in physics.

Another non-curricular support mechanism that departments can offer is a lounge or room specially set aside for physics majors to socialize and discuss and work on physics assignments. More than 80% of the respondents indicated that their department's facilities included such a refuge, and a majority of those reported that they took advantage of it frequently.

POST-DEGREE PLANS

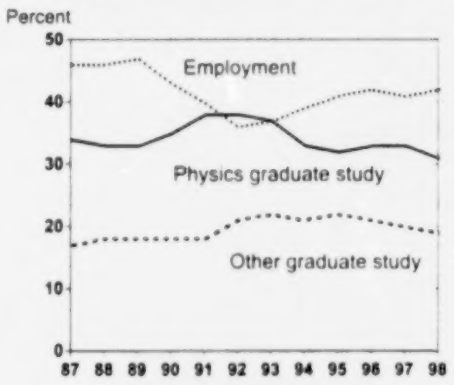
Over the past few years, the immediate postbaccalaureate plans of successive classes of physics bachelor's degree recipients have been remarkably constant (see **Figure 4**). Approximately half of all graduates aim to pursue further studies, with three out of five going on in physics and the rest switching to another field, the most popular choice being engineering. Slightly more than 40% of all graduates plan to go directly into the work world, although previous studies have shown that many of these plan to return to graduate school after a break of one or two years. The other 7% or so, not shown in **Figure 4**, were undecided about their plans at the time of the survey.

Given the high proportion of bachelor's recipients who plan to go on to graduate school either immediately or after a hiatus, students' immediate plans conveyed only a limited sense of their real career goals. The questionnaire therefore also included a question that focused on their long-term objectives. **Table 2** presents how frequently each option was ranked as the students' top choice.

Not surprisingly, these objectives varied considerably depending on the student's immediate postbaccalaureate direction. Among those going on to graduate physics study, by far the most popular goal is an academic career, that is, teaching and doing research at a college or university. Just over 60% make this their number one choice, while the next most popular option — other science or technical position — garners only one-sixth of the first choice votes. Moreover, the fact that an academic post generally requires a PhD helps explain why so few of the students continuing on to graduate study in physics aim to stop at the masters degree level, with seven out of eight expecting to continue on to a doctorate.

Students who go on to graduate study in other disciplines or directly into the workforce have far more varied long-term career goals. Among the former group, in keeping with the large number pursuing graduate studies in

Figure 4. Postbaccalaureate plans of physics bachelors, 1987 to 1998.



Note: Each year 2-8% of the graduates had no post-baccalaureate plans at the time the survey was conducted.

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Table 2. Long-term career goals of physics bachelors, class of 1998.

	%
College/ University teaching and research	30
Pre-college science teaching	5
Engineering	21
Other science or technical position	16
Any other position	20
Unsure	8
	100%

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engineering, the largest fraction (37%) plan to work in one of the engineering fields, while 19% anticipate an academic career. To achieve these goals, 45% hope to earn a PhD, 38% aim for a masters, while the remaining graduates plan to pursue a professional degree, most in medicine or law.

Many of those going directly into the workforce also plan to head into engineering (23%), with the broader array of scientific and technical jobs being the second most popular career direction (21%). Eleven percent see themselves ultimately achieving a professional position outside of science, and 8% plan to become pre-college teachers.

In recent years, there has been a great deal of concern about many physics students' unrealistic career expectations. Graduate school culture is often blamed for generating a far higher proportion aspiring to an academic career than can realistically be accommodated. But the data above suggest that, for many students, these expectations are already well-formed by the time they enter their graduate studies. Unfortunately, of the 60% of the degree recipients heading into physics graduate study who aim for an academic career, only a fraction will ultimately be accommodated.

These unrealistic hopes cannot be blamed simply on negligence in investigating options. When students were asked whether they had talked over career choices with others, 95% answered affirmatively. The most common confidantes were fellow students, followed closely by faculty advisor, other faculty members, and parents. Interestingly, faculty seemed virtually as open to such discussions with those heading towards the world of work or towards other disciplines as they were with those pursuing physics at a higher level.

Moreover, two-thirds of all graduating respondents felt that they were well-informed about what became of previous classes of physics bachelor's recipients. It appears that student organizations like SPS may play a key role in providing this type of information. On campuses where an SPS chapter was present, fewer than half of the students who were inactive were familiar with the paths pursued by previous years' classes after graduation. Among students who were somewhat active, the proportion rose to two-thirds, while, among very active SPS members, the figure reached 90%.

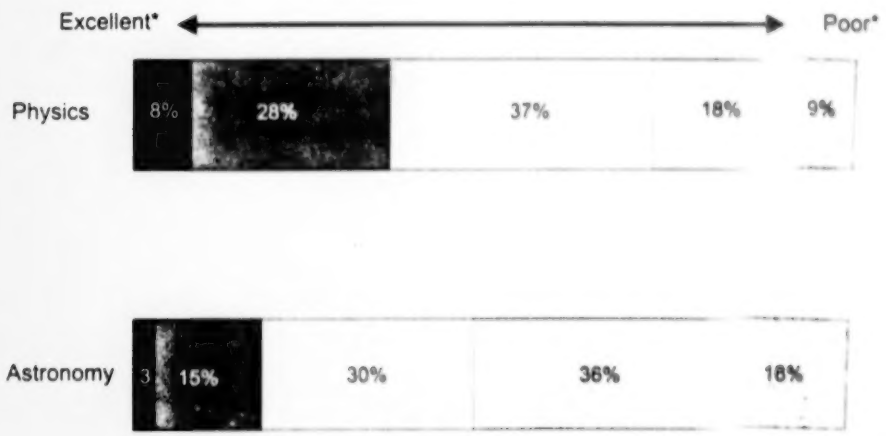
Not surprisingly, those heading directly into the workforce were most likely to avail themselves of the campus career or placement office, although even in this group the proportion doing so was under half. About half of all graduates reported finding information about employment and career opportunities in physics from the world wide web.

Graduating seniors' views of the immediate employment prospects facing new physics bachelor's recipients was far less sanguine than their long-term career expectations. The overall assessment, shown in the top bar of **Figure 5**, was lukewarm at best, although far more upbeat than the perceptions of undergraduate astronomers as shown in the lower bar. It is worth noting that physics graduates moving out into the work world were no more optimistic than their fellows heading towards grad school. And, among the latter, those switching out of physics into other fields for graduate study did not display any greater negativity that might have played a part in their decision.

ASTRONOMY

There were 69 departments granting a bachelor's degree in astronomy in 1998. Just over half of these were independent, "stand-alone" programs, while the balance were combined administratively with a physics department. In the same year, these 69 departments conferred 192 astronomy degrees, slightly more than the previous year. Out of this total, 89 degree recipients responded to the AIP Senior Survey.

Figure 5. Perceived employment climate for physics and astronomy bachelor's, class of 1998.



* Rating on a 5-point scale.

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In many ways, astronomy bachelor's recipients closely resemble their physics counterparts. Unfortunately, in addition to the relatively low response rate, the small overall population size further constrains the level of detail than can be reliably reflected in the findings that follow.

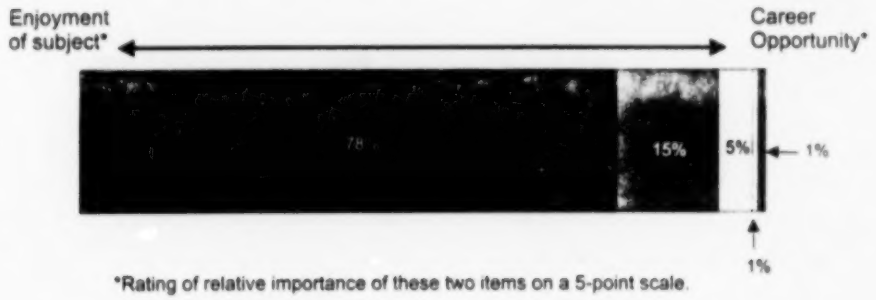
Astronomy graduates seem to be even more academically-oriented than their physics colleagues. As **Figure 6** shows, virtually all of the respondents indicated that they chose astronomy because of their fondness for the subject, not because of its career potential.

As is true in physics, just over half of astronomy bachelor's recipients plan to go directly on to graduate school. But the proportion of this group who aspire to become a university or college professor is even higher among these astronomy majors (71%) than it is among the corresponding group of physics bachelors (45%). In part, this likely reflects the narrower choices available to astronomers in industry.

For probably similar reasons, respondents rate the job market for astronomy bachelor's degree holders as weaker than the market for physics bachelors (see **Figure 5**, bottom bar). While far from the first choice, it is interesting to noted that high school teaching is a more popular option among astronomy majors heading directly into the job market (15%) than is among the corresponding group of physics majors (8%).

Astronomy majors were even more likely to have had an opportunity to do research beyond coursework (86%) than physics majors (72%). And in spite of the limited job market, astronomy bachelors, just like their physics counterparts, expressed overwhelming satisfaction (86%) with their choice of major.

Figure 6. Primary reason respondents majored in astronomy, class of 1998.



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